Consistent Science for Decision Making: Experience with Saturn and the Tool for Reduction and Assessment of Chemical Impacts (TRACI)

Abstract

Sustainable Development (SD) began as primarily an environmental concern that the practices and consumption patterns of current generations would leave future generations a planet with significant environmental problems and devoid of necessary resources. While it is recognized that SD decision making may involve social and economic considerations, to ensure increasing sustainability it is necessary that these considerations are analyzed independently, and that emphasis remains on environmental issues. A decision support framework is presented with a quantitative environmental analysis coupled with a valuation process to determine which of two or more options are better for the environment. The framework recognizes that tradeoffs are involved in nearly every environmental decision, and therefore, defining a consistent framework requires the development of values that reflect environmental priorities. TRACI (Tool for the Reduction and Assessment of Chemical Impacts) is a decision-support tool with newly developed impact assessment methodologies incorporated into the decision-support framework. The Saturn Design ToolKit and LCA case study, which follow the SD decision support framework, will also be featured.

Slide Presentation

Consistent Science for Environmental Decision-Making

Tools for Sustainability Workshop
February 17 - 18, 1999

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Outline

- Discuss methods of determining Sustainable Development progress.
- Present a framework for consistent environmental decision making.
- Show the application of the framework within the Saturn Design ToolKit.
- Present impact assessment methodology developments related to TRACI.

Sustainable Development

"…to meet the needs of the present without compromising the ability of future generations to meet their own needs."

The Brundtland Commission
Our Common Future, 1987

Sustainable Development Decision Making

- May have social, economic, and environmental impacts.
- Categories should be analyzed independently.
- Emphasis should be on environmental impacts to reach sustainability.
- Environmentally - Is A better than B?

Sustainable Development
Methods to Guide Progress:

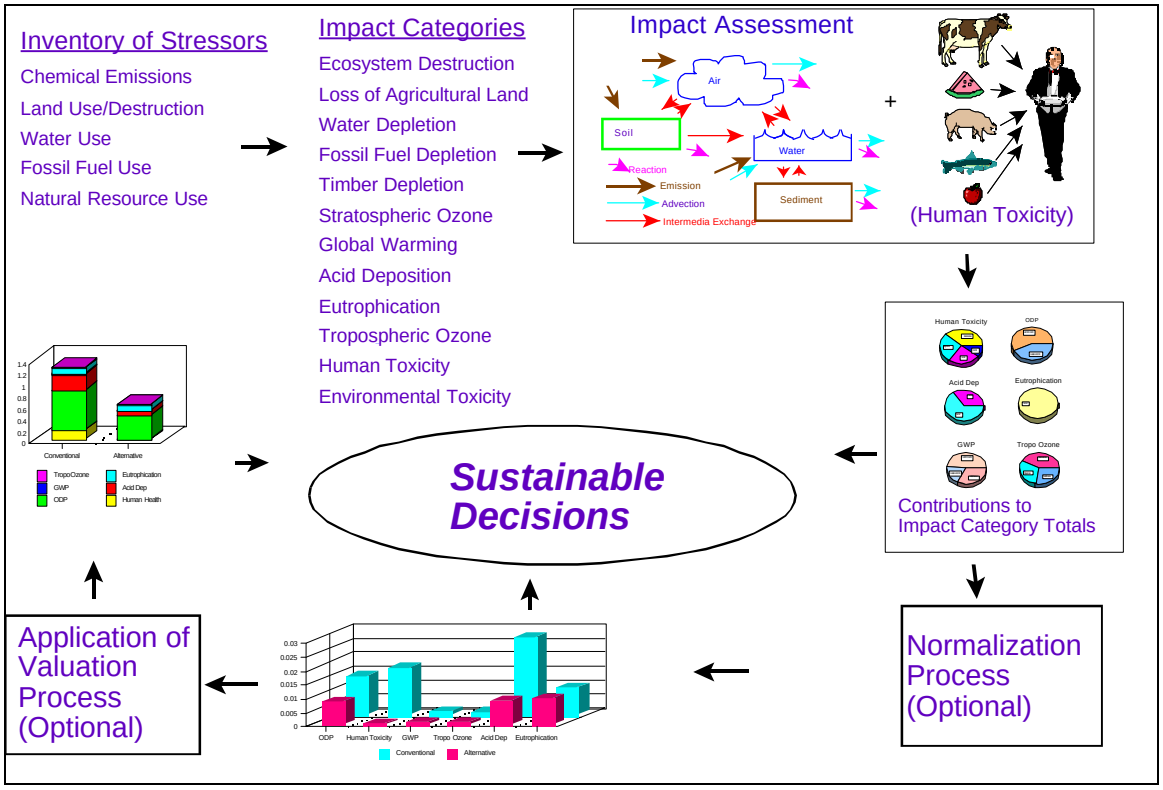
Historical Trend Analysis

Management Philosophies

Comprehensive IA Framework

Comprehensive Impact Assessment Framework

- Presented by P&G at Vancouver NRTEE Eco-Efficiency Conference in ‘98.
- To be presented by Saturn at Sustainable Business Forum in San Jose next wk.
- Being considered for adoption by the AICHE CWRT Sustainability Metrics WG.

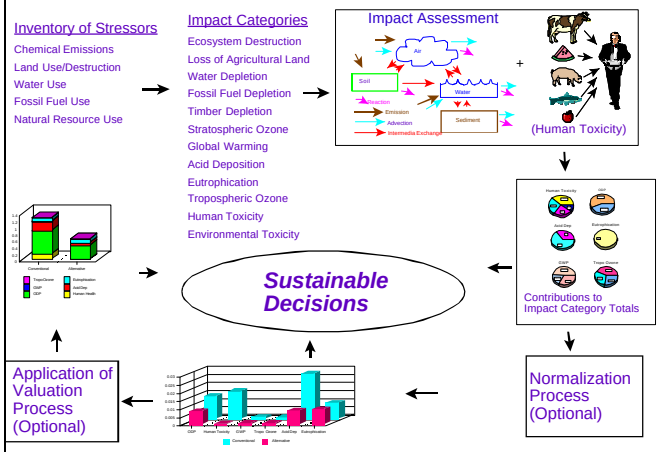

Inventory of Stressors
Chemical Emissions
Land Use/Destruction
Water Use
Fossil Fuel Use
Natural Resource Use
Impact Categories
Ecosystem Destruction
Loss of Agricultural Land
Water Depletion
Fossil Fuel Depletion
Timber Depletion
Stratospheric Ozone
Global Warming
Acid Deposition
Eutrophication
Tropospheric Ozone
Human Toxicity
Environmental Toxicity
Impact Assessment
Air
Soil
Water
Sediment
Reaction
Emission
Advection
Intermedia Exchange
(Human Toxicity)
Contributions to
Impact Category Totals
Normalization
Process
(Optional)
Sustainable
Decisions
Application of
Valuation
Process
(Optional)
Conventional
Alternative

Consistent Environmental Decisions

Provides consistency in environmental decisions.

Allows decisions when trade-offs exist.

Values become transparent.



May be utilized over full life-cycle.

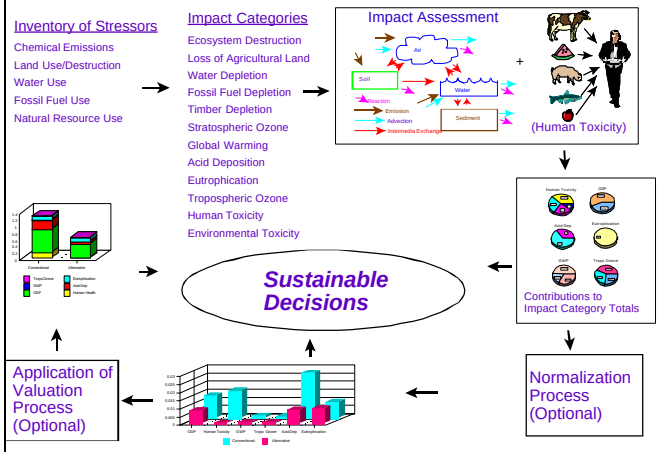
May incorporate best assessment methodologies.

May allow analysis of critical decision elements.

Challenges

The decision is only as good as the data and methodologies that support it.

No standard impact categories or methodologies.



Uncertainty may not allow differentiation.

More detailed assessments may be necessary at selected sites.

Little guidance for Valuation Process.

Saturn - Design ToolKit

John Resslar, Saturn.
Mary Swanson, et al. @ U TN.
Julie Winters, OPPT.

Implementation of SD decision framework.
To prove continuous environmental progress.
Integrated into Saturn design process.
Including emissions and resource depletion.

Discernment Workshop

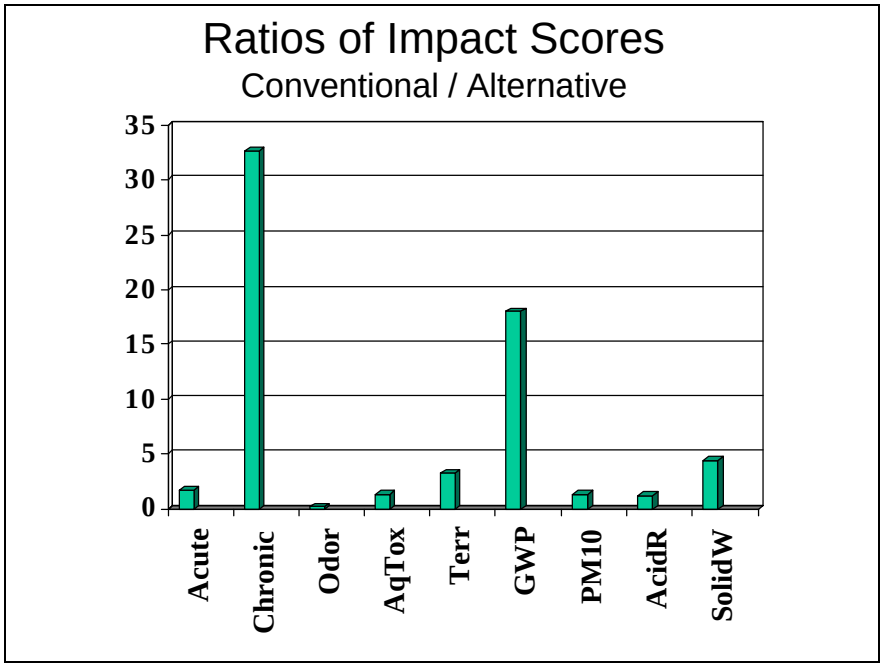
- Designed for Saturn management philosophies. Discernment Workshop in Jan. 97 with Saturn's top environmental management.
- Allowed to add, subtract, aggregate, or disaggregate impact categories.
- Placed numerical value on the relative priority of impact categories using AHP.
- Provided greater focus -> leading to greater certainty for high priority categories.

Design ToolKit

- High quality inventory through Suppliers' Council. Secondary sources filled gaps.
- Impact Assessment Methodologies best available at time. Further development for high value impact categories.
- Two modes available - Whole Auto Screening Assessment or Detailed Assessment of Individual Components.

Saturn LCA Case Study - Alternative vs. Existing Plastic

- Minor design change being considered for interior door trim of the Saturn automobile.
- Prototype manufactured in Troy MI.
- Preliminary analysis calculated performance and cost advantages.
- Use phase identical - Weight didn't change.



Results of Study

- In all but one of the categories the alternative was superior to conventional.
- Only category favoring conv. was odor.
- Alternative plastic favored for recylcability.
- Alternative plastic will be used.

TRACI - Tool for the Reduction and Assessment of Chemical Impacts

- Dr. David Pennington, ORISE.
- Dr. Greg Norris, Sylvatica.
- Dr. Tom McKone, UC, Berkeley.
- Dr. Edgar Hertwich, UC, Berkeley.
- Dr. Bill Pease, UC, Berkeley.

TRACI Impact Assessment

As close as we can get to “Ideal.”

Sophisticated simulations for each category. Five impact assessment methodologies are newly developed.

Sophisticated uncertainty analysis conducted.

Transparent picture of limitations.

TRACI - What's New

- Assessing the level of sophistication and resolution necessary.
- Realizing inconsistency in practice.
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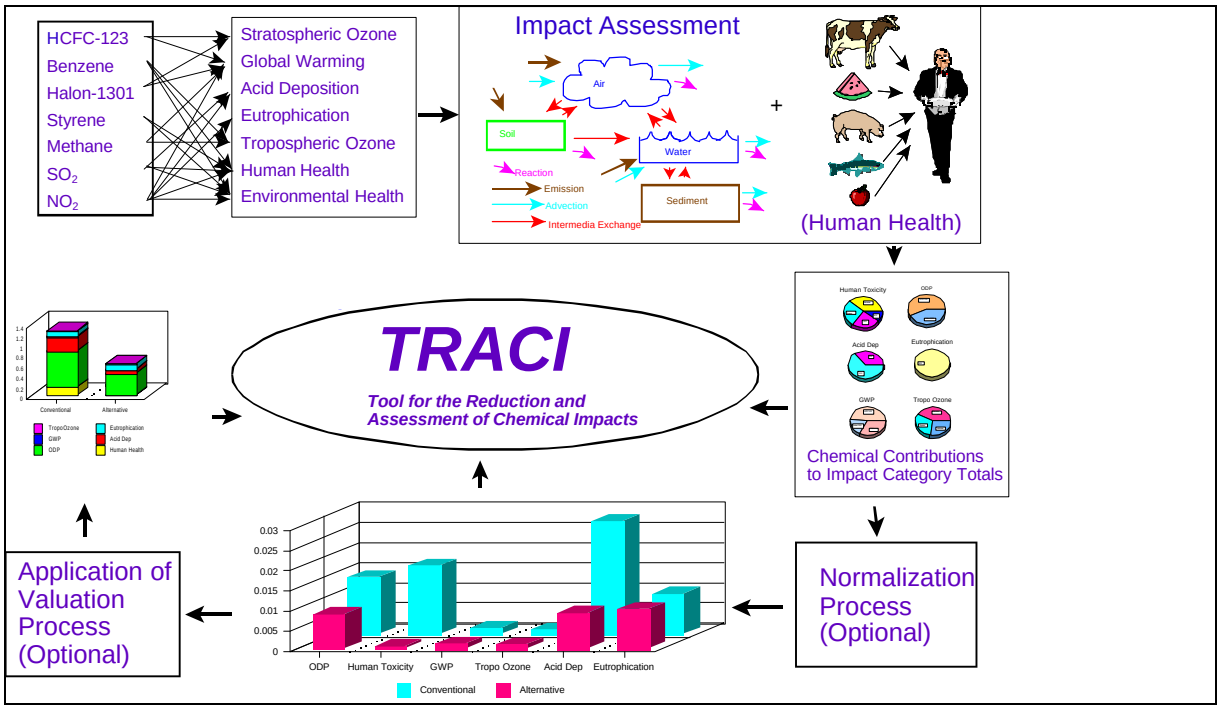
- Ex. -> How location specific should LCI data be to minimize the uncertainty?
- When this level of detail is not available What is the next best default?
- How much uncertainty was added?



Human Toxicity

- CALTOX - based
  - multimedia model to determine concentrations
  - twenty-three human exposure pathways to determine human health potentials.
  -
- Analyzed the modeling parameters (e.g., meteorology, geology, chemical/physical properties) using sensitivity analysis.
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- Developed human health potentials for U.S.

Human Toxicity Findings

- Variability (including landscape) smaller than parameter uncertainty. Important factors included: source of drinking water, intake of fish, and land area covered by surface water.
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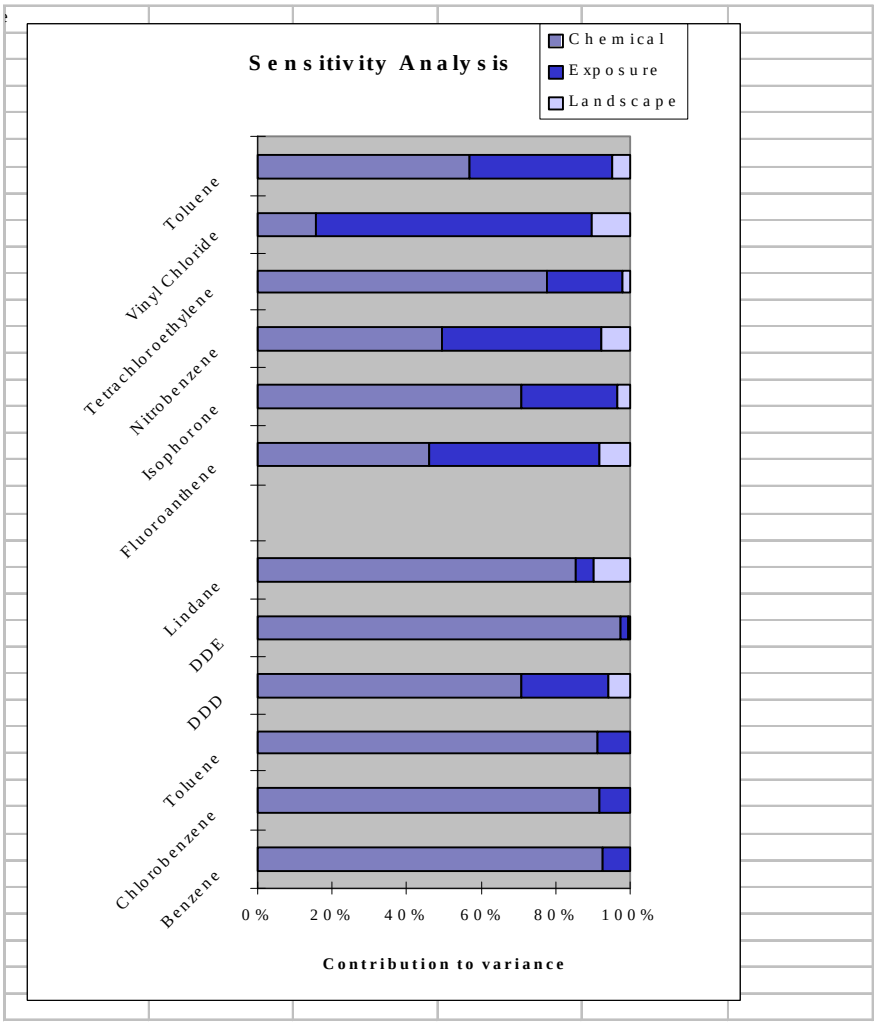
- Most significant parameter uncertainty: chemical half-lives in air and surface water, partition coefficients between particulate matter and air, and BCF.


Sensitivity Analysis
Chemical
Exposure
Landscape
Toluene
Vinyl Chloride
Tetrachloroethylene
Nitrobenzene
Isophorone
Fluoroanthene
Lindane
DDE
DDD
Toluene
Chlorobenzene
Benzene
0%
20%
40%
60%
80%
100%
Contribution to variance

Ecotoxicity

- Similar to Human Health Equivalency Factors using CALTOX with new environmental exposure models, perhaps similar to European USES.
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- UC Berkeley and David Pennington also involved in SETAC-Europe LCIA WGs for Fate and Transport, Human Toxicity and Ecotoxicity.

Methodology Development for Acidification, Eutrophication, Smog Formation Potentials

- Available and proposed approaches offered to International. expert panel for comment.
- Workshop results being documented.
- Continuing development of impact assessment methodologies.
- Compare to older characterization factors, deterministically and probabilistically.

TRACI Status

- Development of Impact Assessment Methodologies Progressing.
- Programming Continues.
- Expect beta version in 2000.
-

Challenges
Future Work?

- Data quality & availability for inventory and impact assessment -> toxicity, chemical/physical properties.
- No threshold limits. Assumed potential for effects at lowest levels of concentration.
- Inability to address antagonistic/synergistic effects.
- Database for background concentrations and emissions sources (anthro- and non-anthropogenic) undeveloped.
- Little guidance for valuation process.

Conclusions

A consistent decision framework is possible for SD, LCA, and P2 applications.

Development of tools continues.

Future and current research includes:

Environmental decision support,
Application of impact assessment, and
Dev. of impact assessment methodologies.

Acknowledgments

Warning: Views may have been tainted from the following affiliations.

- SETAC-Europe Working Group for LCIA.
- SETAC-NA LCIA Workgroup.
- ISO 14042 LCIA - U.S. and International.
- AICHE CWRT Sustainability Metrics WG.
- UC, Berkeley.
- Sylvatica.
- U of Tennessee.
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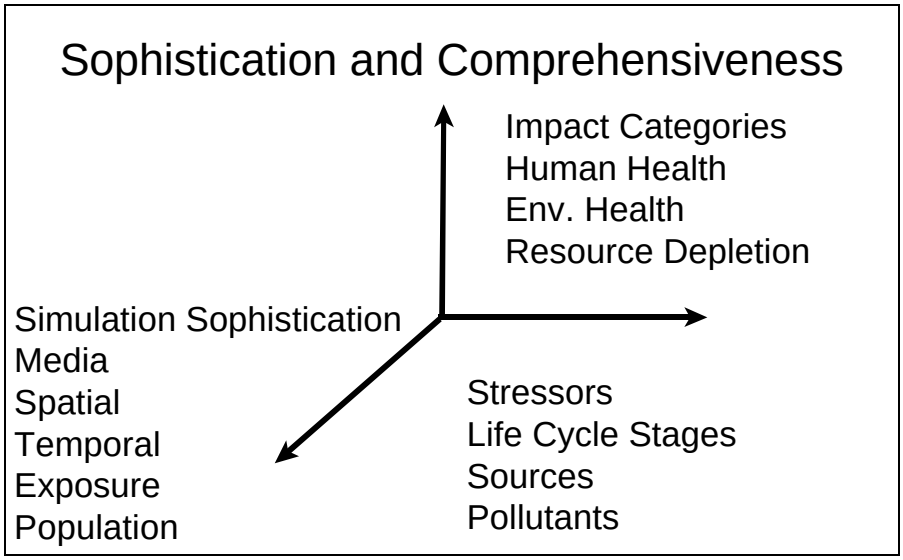
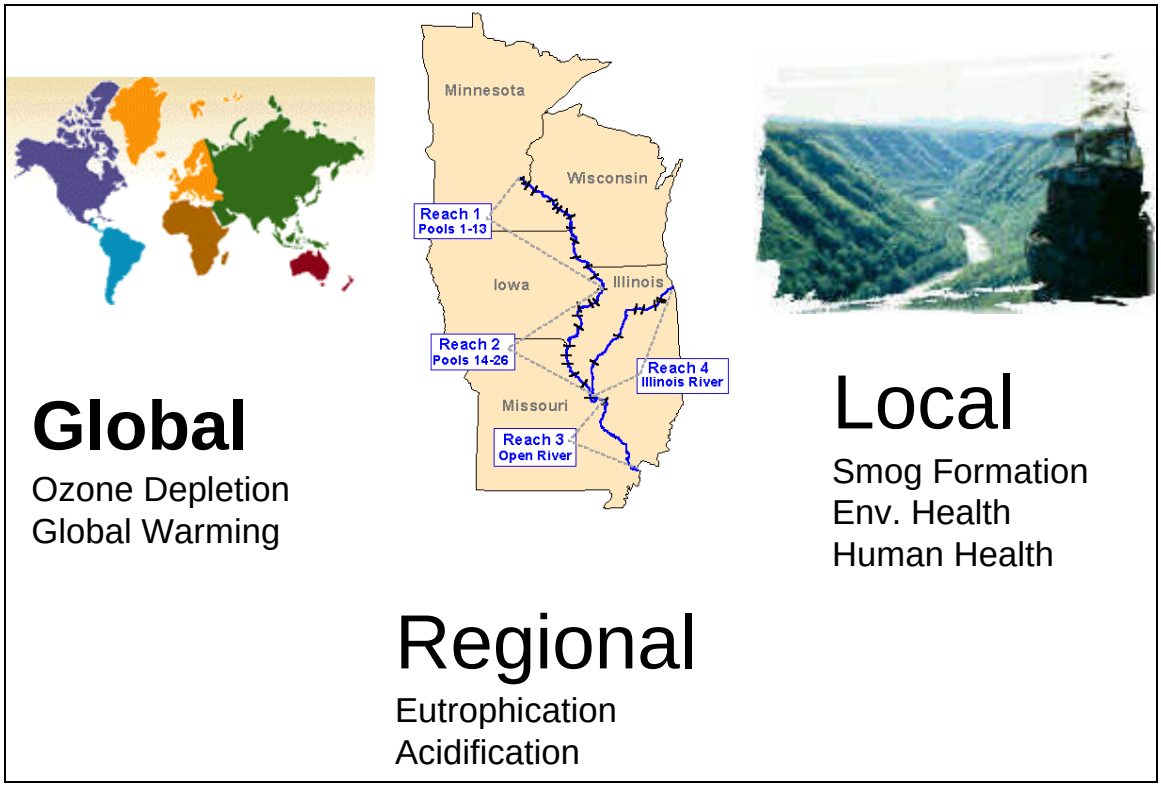

Sophistication and Comprehensiveness
Impact Categories
Human Health
Env. Health
Resource Depletion
Simulation Sophistication
Media
Spatial
Temporal
Exposure
Population
Stressors
Life Cycle Stages
Sources
Pollutants


Minnesota
Wisconsin
Iowa
Illinois
Missouri
Reach 1
Pools 1-13
Reach 2
Pools 14-26
Reach 3
Open River
Reach 4
Illinois River
Global
Ozone Depletion
Global Warming
Local
Smog Formation
Env. Health
Human Health
Regional
Eutrophication
Acidification

- The Country that figures out how to do environmental assessment in the manner closest to the impacts felt by Nature will have an environmental and economic advantage.

Outside Communication

- Intl. workshop on LCIA sophistication.
- AICHE Sust. Metrics WG.
- SETAC-NA LCA WG.
- SETAC-Europe LCIA WG.
- ISO development process.

I AM Approach

To conduct research which leads to increasing ability of environmental decision support to incorporate impact assessment methodologies which reflect the actual impacts experienced by the environment.

I AM Team Vision

To

Influence Environmental

Decision Making

through the Research, Development, and Application of Environmental Impact Assessment and Progress Measurement

Speaker Biography

Jane Bare is a chemical engineer and the Impact Assessment and Measurement (I AM) Team Leader within the Systems Analysis Branch. The I AM Team strives to influence environmental decision making in SD, LCA, and P2 through the research, development, and application of comprehensive environmental impact assessment and progress measurement.